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Interactive comment on "Mesoscale modeling of combined aerosol and photo-oxidant processes in the eastern Mediterranean" *by* M. Lazaridis et al.

M. Lazaridis et al.

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We have received extensive comments and suggestions from the Editor mainly and the Referees concerning the manuscript "Mesoscale…eastern Mediterranean" by Lazaridis et al. In the following we reply one by one to the Editor's points and the Referee's points. The revised paper reflects these points.

Interactive reply to Anonymous Referee #1

We would like first to thank the anonymous referee for his extensive and constructive comments. We appreciate the points raised by the Referee that the "the paper presents novel work...for the eastern Mediterranean". Indeed, in our knowledge the current modeling application is one of the first ones to apply a mesoscale air quality model in

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the Eastern Mediterranean and to compare the modeling results with field data.

General Comments

We have to note that the application of the UAM-AERO and the RAMS models is not a trivial modeling task since it involves a major work to simulate the atmospheric dynamics in 5×5 Km^2 grid. In all similar mesoscale applications the modeling period is limited to few dates (e.g. Lurmann et al., 1997). We have chosen 2 periods (13–16 July 2000, 26–30 July 2000) during the summer measurement campaign. The second period coincides with the use of the research vessel measurements and the first with meteorological conditions which dominate the regional transport in the domain. Therefore, the selection of the modeling periods was not arbitrary and was done since these were the most "interesting" periods to study.

The specific objective of the current modeling work is mainly to evaluate and assess the importance of the local sources versus the transport component for the ambient concentration of the photochemical pollutants and fine particles in the eastern Mediterranean area. Another objective is the importance of the natural sources for the concentration of the particulate matter and ozone. The comparison between experimental field data and modeling results is aiming to verify the model applicability in the area under study. The above facts also reflect the selection of the 2 periods during summer. During the winter campaign we have modeled the whole period since it was just few days.

The current paper presents an application of the UAM-AERO model combined with the RAMS meteorological model. The sensitivity of the model and the model uncertainty has been studied in the scientific literature and is not part of the current work. The paper by Lurmann et al. (1997) (and the References herein) serves the purpose of model evaluation. In addition, the accuracy of the measurements were not presented since this is the aim of the paper which presents the measurements. The paper by Smolik et al. (2003) is a published work concerning the measurements and information

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on the impactor measurements can be found.

Comments on the model treatment of emissions

1) Indeed a detailed discussion of the chemical scheme and the emission inventories for biogenic compounds is not presented. A short discussion in the section 2.2 for the ozone sources has been added in the revised version of the manuscript.

However, the limitations and sensitivity of the chemical scheme used in the UAM-AERO model is beyond the objectives of the current paper. The CB-IV mechanism is a well known, documented, tested and applied in several applications in the scientific literature. We refer to the paper by Lurmann et al. (1997) and the references herein.

2) A detailed description of the UAM-AERO model modules is given in the paper by Lurmann et al. (1997). We will refer to the paper by Lurmann et al. (1997) in the revised version explicitly concerning the deposition routines. The model is run for each period separately. Therefore 3 different modeling periods have been initialized and the run has been performed for the periods mentioned.

3) The emission inventories for crustal dust is a scientific area under study and the general conclusion in the scientific literature is that under-prediction occurs. The tables which the Referee points refer to average values and no certain conclusions can be drawn from there. However, I agree that the paper must state the facts about the comparisons in Tables 1–2 and this has be included in the revised manuscript. Actually, this was a requirement from the second referee also.

4) A detailed description of the UAM-AERO model modules is given in the paper by Lurmann et al. (1997). We will refer to the paper by Lurmann et al. (1997) in the revised version explicitly concerning the gas-to-particle conversion routines.

5) Further statistical analysis is beyond the scope of the current paper. However, we have attempted to discuss the reasons for the discrepancy between modeled and measured data for specific dates. Text has been added in the revised manuscript. A short

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discussion also has been added for the meteorological factors affecting Na concentrations at the Finokalia station.

6) Concerning the comparison between ozone modeled and measured values the comparison is satisfactory. This is stated based on the fact that in general air quality models with agreement with measurements close to 10–20 ppb are considered satisfactory. In the revised version of the paper we have added few sentences discussing the limitations of the chemical scheme for the production of secondary organic compounds and photo-oxidants.

7) We have rephrased the model/measurement comparison discussion to reflect the Referee comments.

8) In the revised version of the manuscript we have added a similar Figure such as Figure 7 for the boat measurements.

9) I agree with the Referee that the comparison of the measured meteorological data with the RAMS model is an interesting work but beyond the focus of the current paper. However, we have discussed the possible reasons for the discrepancy between modeled and measured data for January based on the meteorological conditions.

Technical corrections

The technical corrections have been implemented in the revised version of the manuscript. We want once again to thank the Referee for his detailed reading of the paper. More specifically:

Page 5458 line 6.
The change has been performed.

Page 5459 line 20.
The “s” has been removed.

Page 5460 line 23.

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The “the” has been removed.

Page 5462 line 6.
The sentence has been re-written.

Page 5464 line 11.
The “the” has been added.

Page 5464 line 22.
The change has been made.

Page 5464 line 29.
The “The” has been removed.

Page 5465 line 5.
The “then” has been removed.

Page 5465 line 15.
The changes have been performed.

Page 5465 line 29.
The “the” has been removed.

Page 5467 line 27.
The 12th July has been removed from the sentence since we have not modeled the specific date.

Page 5469 line 11.
The sentence has been re-written.

Page 5514 figure caption.
The figure caption has been changed.

Interactive reply to Anonymous Referee #2

We would like first to thank the anonymous referee for his extensive and constructive

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comments as well as for the specific suggestions concerning both the presentation and discussion of the model performance.

General Comments

P5466, line 20 to 26: In the revised manuscript a discussion will be included concerning the model limitations (CB-IV) and the importance of biogenic emissions which however are included in the emissions. We will discuss the importance of the inclusion of a new parameterization for the production of condensable organic components (COC) and ozone from biogenic emissions. Actually, we have included a biogenic COC module in the UAM-AERO but it is still in testing.

In addition, we want to refer to the Referee point that "extremely loose relationship exists between the model and the measurements for O_3". Concerning the comparison between ozone modeled and measured values the comparison is "satisfactory" for people working in the modeling. This is stated based on the fact that in general air quality models with agreement with measurements close to 10–20 ppb are considered satisfactory. In the revised version of the paper we will add 1–2 sentences discussing the emission modeling facts and limitations as we have stated above.

P5466-7: The 3-D excel style has been changed in Figure 7 as suggested by the Referee.

Concerning the sea salt and crustal levels on January. On January 10 a relatively strong north-westerly synoptic flow is evident over the Central and NE part of the Mediterranean. This flow dissipates throughout the following 24 hours. This strong winds are responsible for the elevated sea salt concentrations compared to other dates such as 11 th and 12 th January. On January 11 to 12, the synoptic flow over the area under consideration is relatively weak. The wind field over the land is modified by the landscape. Over the Aegean maritime area a weak northerly current is evident. On January 13 a new depression from the west reaches the Central Mediterranean. These winds lead to elevated emissions of crustal material compared to the 10th of January

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where the NW winds bring elevated sea salt concentrations.

The measurement and modelling variability has been added in the tables where the range of the measurements has been given. There is a discrepancy between the gravimetric measured PM10 concentrations and the chemical resolved composition. This is due to organic mass, water and experimental errors. The concentration of particulate organic matter (POM) was determined by multiplying the OC concentration by 1.7, which is the average ratio of the mass of carbon-containing species to carbon mass assumed to be distributed between the fine and coarse modes with a ratio of 7/3 (Quinn et al., 2000). This may be an uncertainty factor in the calculation of the organic mass present in the PM10 concentration. Furthermore, a short sentence has been added for the meteorological factors and their influence for the sea salt and dust loading.

Quinn, P.K., Bates, T.S., Coffman, D.J., Miller, T.L., Johnson, J.E., Covert, D.S., Putaud, J.P., Neususs, C., Novakov, T., 2000, Comparison of aerosol chemical and optical properties from the 1st and 2nd Aerosol Characterization Experiments, Tellus, 52B, 239–257

P5469. A short discussion has been added in the revised paper (in the Results section) concerning the possible factors for the discrepancy between modelled and measured aerosol mass and its chemical constituents. In addition, it is explicitly stated that Figure 7 refers to modelled results.

Presentation issues

The presentation issues are implemented in the revised version of the manuscript. A careful revision of the manuscript has been performed following the Referee suggestions. More specifically:

P5460, line 3-4.
The innermost rectangle has been coloured red.

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P5461, line 23.
A rephrasing has been made in the revised paper.

Figure 1 caption.
The mixing ratio is used instead of concentration in the revised manuscript.

Page 5462, line 11.
A rephrase has been made in the revised manuscript.

Page 5463, line to 5. . .
We understand that the discussion of the broad synoptic conditions is valuable but a graphical illustration is needed. However, the “Black sea” and “Dardanelles Gap” is outside the modeling domain and we speak about regional meteorological conditions. It will require considerable effort and a number of figures to describe graphically the meteorological conditions and we feel that this is beyond the scope of the paper. We refer to the paper of Kallos et al. 1999) in the paper where a clear discussion of this issue is presented.

Page 5464.
The label has been removed and the necessary changes have been performed.

Page 5464 and 5465. (Figures 3–4).
We feel that the outline of Figures 3–4 are useful for the reader to understand the regional transport to the domain, the input of the Athens area and Greek mainland as well as the meteorological conditions in the area. It is also useful for the reader to see as an example the different spatial surface concentrations of several pollutants. Instead we have used line plots for the vertical concentration profiles for ozone as shown in Figure 5. In addition, I do not know about the animations possibility in the ACP journal. It is possible to add an animation if there is this possibility.

p. 5465 (Figure 5).
The profiles are from the UAM-AERO model. The CTM-NILU was used to get the initial

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and background ozone concentrations. We have rephrased the sentence in the revised manuscript.

P5460, line 15.
The word “quite” etc has been removed in several places in the revised manuscript.

P5461, line 23.
The word “also” has been removed.

P5462, line 5.
A rephrase was performed.

We want once again to thank the Referee for his detailed reading of the paper.

Sincerely,

Mihalis Lazaridis

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 5455, 2004.